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PUBLIC RESEARCH UNIVERSITIES IN LATIN AMERICA AND THEIR RELATION TO ECONOMIC DEVELOPMENT[1]

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1. INTRODUCTION

In 1990, the average incidence of poverty and extreme poverty[2] in Latin America was 48.3 per cent and 22.5 per cent respectively. The slow economic expansion experienced since then plus the reorientation of public spending towards social needs managed to only partially alleviate this situation, but was far from sufficient. Indeed, in 2005, 38.5 per cent of Latin America's total population of 556 million was still poor (ECLAC, 2006). This percentage is similar to the one recorded in 1980, thus implying that the absolute number of poor people in our region is much higher today than twenty five years ago. This impoverishment has been accompanied by the deterioration of labor market conditions, with informality and open unemployment reaching historical peaks.

Given this pressing social context, it is evident that Latin America faces the urgent challenge of achieving high and sustained rates of economic expansion and of employment to alleviate poverty. To meet this challenge, it will have to modernize its productive structure, its machinery and capital equipment, to be able to compete in world markets on the basis, not of low wages, but of increased value added and technological sophistication. Such transformation requires an increasingly qualified labor force combined with a dynamic entrepreneurial sector with a strong commitment to innovate. Such combination is indispensable to reduce the gap in the region's pace of technological and scientific progress -and ultimately economic development- relative to industrialized nations.

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[2] Poverty is currently defined as material deprivation, low achievements in education and health, and vulnerability and exposure to risk (World Bank, 2001, p.15). In practical terms, extreme or absolute poverty is defined as one dollar a day of per capita consumption (World Bank, 2001, p.17) that part of the population living below this poverty line is living in extreme poverty.

The challenge is daunting given Latin America's laggard economic performance, and the constraints imposed on the region policy options by global markets and international capital flows. The situation was been further complicated in Latin America by the Washington-Consensus based reforms that weakened the State's capacity to intervene in the economy and brought about a reduction in public investment that was far from fully compensated by the private sector.

As we here argue, strengthening Latin Americas' public universities -and in general its institutions of higher learning and research- is a key requirement to increase the international competitiveness of its productive structure and enter a platform of high and long-term economic expansion. Indeed, in the region, public universities are the key institutions that keep pace with advances in science and technology. Without this knowledge it will be highly improbable for the region to succeed in its quest for economic development. What is the economic impact of public universities? What are the channels through which public research universities foster technological innovation in Latin America? How can these channels be made more efficient and effective to promote economic development? What are their main obstacles in this regard?

Before addressing some of these issues, an important caveat is necessary. This is that assessing the economic impact of universities in developing countries is not an exercise carried out frequently. For example, although since the 1990s there has been a rapidly growing literature on this issue for developed economies,[3] just a few months ago concluded the first ever study to quantify the economic effect of Cambridge University (CU).[4] According to its results, its impact on the British economy amounts to a total of 58 billion pounds over a ten year period (CAM, 2007). For Latin American universities a similar exercise is yet to be carried out. One of the obstacles to do so is the lack of some of the data necessary to apply the methodologies designed for developed nations.

It is important to stress from the beginning that by addressing their economic effect our research focuses only on one aspect of the diverse roles and responsibilities of Public Universities. Moreover, in our view, their economic impact is just one aspect of their social influence in developing countries, and not necessarily the most relevant one. In fact, we tend to agree with the view that in Latin America, Public Universities are the *conscience* of the society in which they emerge (Palencia, 1982). Indeed, these institutions have been fundamental influences in building citizenship and in strengthening democratic values in our region. As an illustration, recall that in Latin America's not too distant undemocratic past it was unfortunately rather frequent to see troops or paramilitary groups entering public universities' premises to violently repress professors/student organizations and jail or disappear some of their leaders.

In addition, in our region, public universities have and still play a key role in teaching and research advancement in philosophy, and many fields of arts and sciences; some of which typically tend to be inadequately funded or covered by private institutions. And, given their much lower fees, Public Universities have traditionally been a fundamental entry-door to higher education for middle classes and -to a certain

[3] See in particular the excellent review by Drucker and Goldstein (2007) where they identify four different methodological approaches to measure the regional economic impact of universities.

[4] As quoted in CAM (2007), this pioneering research by the East Development Agency in addition indicates that the University "contributes 961 million pounds to the economy in direct expenditure. It employs 11,700 people, and in total supports more than 77,000 jobs".

extent- lower classes lacking the means to pay private graduate training. These functions strengthen social cohesion, the creation of human capital, and the diffusion of knowledge. In synthesis, and for the above mentioned reasons, the contribution of Public Universities to Latin America's development covers a series of social, cultural and political functions that can not be assessed exclusively in terms of their economic impact. In particular, we believe that Public Universities in Latin American play a key role in preserving and expanding our culture and historical heritage, a role of most importance in the context of globalization.

2. HUMAN CAPITAL FORMATION, ECONOMIC GROWTH AND ECONOMIC THEORY

A main tenet of our analysis is that Latin America's economic growth requires investment and the application of technological and scientific progress to modernize the region's production processes. To achieve this, it must devote more resources to expand and improve three key elements of the region's innovation systems: i) scientific infrastructure, ii) supply of highly qualified research personnel, and iii) working links between research centers and productive firms. In other words, governments interested in enhancing the growth potential of their economies must devote efforts to improve the local physical and human capital able to carry out research and development, (that is the supply side of the story). And, simultaneously, they must also create the conditions to ensure that the national science and technology centers have relevant, effective and efficient links with the domestic business sector; in other words, they must induce a dynamic demand for science, technological innovation from the local business sector. The failure to pay attention to this aspect leads to the paradoxical situation where many countries in Latin America, and in other developing economies, are dedicating precious public resources to send some of their young bright minds to receive graduate training abroad in high-tech areas only to find out that a substantial proportion of them will not return to their countries because they find no demand for their skills!

In Latin America, public universities are the institutions where most local scientific and technological research & development is carried out, and where most students in these fields receive their formal training. Some of these institutions, certainly not the majority, are of top international quality. In fully industrialized countries, such activities of research and development are done mainly by private universities and by the technological departments of private and public firms. But perhaps the major difference on this matter between developed and developing nations is rooted in the nature and relevance of the links between the universities and the local business sector. Indeed, in the region such links are weak, with scant association between the research agenda of the former and the business needs, the technological pressures to reduce costs or to innovate of the latter. Correcting this deficiency requires systematic, firm government intervention to create a collaborative working agenda between academic institutions and local firms, private or public ones. This effort goes beyond the fundamental role that the State must play in financing the development of science and technology (including the professional training).

From kindergarten to graduate and post-graduate schooling, widespread access to quality education has an intrinsically high social value, reflected in a better educated population, a richer material well-being, and stronger social cohesion. In fact, average educational achievement is typically considered a key indicator of a country's human development. In countries that have or are successfully moving on the road to

development, education plays a critical role in improving the skills and productive capacities as well as in promoting social integration and upward mobility. Technological progress is directly linked to scientific research and, thus, to the training of scientists and engineers. In general it is mainly in universities and technological institutes where such training is provided. Public universities and academic centers are the source of the vast proportion of all the research done in developing countries. In Latin America the vast majority of research and development projects is financed or carried out by State institutions; with more than 75 per cent of all graduate students enrolled in public universities and, on average, approximately 80 per cent of the total population of researchers employed in such public entities (Tunnerman, 2003).

Besides the direct impact that education has had on each nation's economic development through the advance in science and technology, it directly increases the personal income in a direct fashion: in general higher levels of attained education are associated with higher remunerations and income. Education has a direct potential impact also on economic equality. It is not surprising to find in the medium run that the less educated a population is, on average, the lower its per capita income will be and, perhaps too, the more concentrated its income distribution will be.

Paradoxically, the undeniable and conspicuous relationship between, on the one hand education –particularly tertiary and graduate– and on the other hand technological change and economic growth had not been well captured by the standard theoretical models within the mainstream economics profession until a few decades ago. In fact not so long ago, such literature saw technological change merely as the residual in growth accounting exercises, determined in an exogenous and independent way of investment (Sala-i-Martín, 2000). A notable exception was Kaldor's theoretical work on economic growth (Kaldor, 1957) which stressed the fact that technology changes are incorporated in new investments. Thus, in his work, research universities have a direct economic effect associated to the diffusion of scientific and technological changes, in addition to their impact on human capital formation. It was not until the advent of the so-called New Growth Theory that such shortcoming of mainstream economics was corrected, and technological change was recognized as an endogenously determined influence on structural change and economic growth at the micro and the macroeconomic level.

Today, the literature on growth economics recognizes the relevance of human capital formation and technological advancement for development. Among the main contributions within the neo-classical school stand out Romer (1986, 1990) and Lucas (1988) and within a neo-Schumpeterian view Aghion and Howit (1992), as well as Dosi (1984) and Metcalfe (1995) from a structuralist/evolutionist school. Whether through their effects on the surge of new products or processes, on the increased competitiveness of firms or on the expansion of their markets, *inter alia*, these authors recognize research and education as essential ingredients of a dynamic and internationally competitive economy.[5]

But independently of when did mainstream economic theory formally incorporated knowledge, embodied in the notion of human capital and technology, as a

[5] For the purposes of this paper it is important to underline the strand of research produced in Latin America in, say, the last ten years focusing on the links between universities, science/technology and human capital formation and their impact on economic growth (see *inter alia*; Cimoli, *et al.* 2005, 2006; Tunnerman 2003, Malo 2005 and, for a more global perspective see Shahid and Nabeshima, 2007).

main determinant of economic growth, it was recognized as an important, new factor of production based on innovation (Soubbotina, 2004; Watkins, 2005; Guinet, 2005; Feldman and Stewart, 2007; Yusuf and Nabeshina, 2007). The chain of influence of knowledge from higher education to economic growth is illustrated in Figure 1.

<FIGURE 1 ABOUT HERE>

Two particular relations of this diagram stand out for the case of developing countries. The first one shows how scientific activities are related -through innovation- to the production of wealth and income, and job generation. The second relation is the link -here denominated the technology transfer office- between the University and the business sector. The weakness or absence of this link is of utmost significance, and is a phenomenon that worries both developing as well as developed economies. Indeed, in no country scientific research and technological innovation are linked in an automatic, relevant way to the production process, unless there is an agent or institution (here named the TTO) responsible of fostering, of building such links. The institutional expression of this transfer unit depends in part on State policies and in part on the form of participation of the local business sector (Yusuf, 2007). In any case, the absence or fragility of such institutions is worse in Latin America than in Western Europe, or the developed world.

3. Technological Progress and Latin America's Current Quest for Growth in the Global Economy

Parallel to the above mentioned progress of economic theory in understanding the contribution of innovation and research to development, the world's economic structure and political scene changed dramatically, in an overall context marked by the swift pace of technological progress. Indeed, the intense and rapid advance of science and technology has been an outstanding aspect of this era. Areas like computers, micro-electronics, robotics and biotechnology and their applications in communications, production and services have flourished. This has modified the demand and consumption patterns in most countries, as well industrial processes, and is re-mapping the world matrix of trade and production of goods and services.

Developing as well as developed nations are finding that their international competitiveness -and economic growth potential- is based more and more on their technological prowess and ability to adapt it, to innovate in niches or across the board in different industries. New competitors, like China and India, have abruptly appeared in the international trade scene, putting pressure on Latin America to transform and modernize its productive structure. To meet this challenge, Latin America will have to boost qualitatively its teaching, training and research capacity to innovate. Without it, a sustained and robust long-term economic expansion will, simply, not happen.

To better gauge the relevance of public universities to promote Latin America's economic development today, at the brink of the XXI Century, it is useful to start with a brief overview of its recent growth performance and economic outlook; paying attention to the relevance of research and technical progress. This overview will help to identify the key constraints that bind the region's long-run economic expansion and, in this regard, the ways in which public universities contribute to remove them.

3.1 Economic Liberalization and Growth in Latin America: 1980-2006.

In the 1990s, in the aftermath of the debt crisis, Latin American governments launched radical reforms to eliminate trade protection, liberalize financial markets and cut down the State's intervention in the economy. This new, neo-liberal, strategy was drastically implemented in the region. The public sector was downsized and state enterprises either shut down or privatized. Most subsidies and industrial policies were cancelled. Development banks and other public institution aimed at fostering planning and development were weakened. Trade protectionism was eliminated, and financial and other markets were deregulated and opened to international competition, increasing the role of private capital -particularly foreign capital- on the allocation of investment.

The reforms however had frustrating results on the region's development. They did reduce inflation and fiscal deficit, and brought about an export boom in Latin America. However, they were unable to trigger high and sustained economic growth or job creation. Indeed, for the vast majority of countries in the region, investment has been laggard, and the pace of economic expansion far from dynamic. In fact, the average rate of growth of real GDP per capita -as well as of labor productivity- has since then been much lower than what it used to be in 1950-1980, *i.e.*, before the neo-liberal, macroeconomic reforms were launched. Poverty, as mentioned above, still afflicts a vast proportion of our populations, the region is not catching-up with the developed world, and the gap between the have and the have-nots is widening.

Why did the reforms fail? First of all, private investment did not compensate for the decline in public investment. The lack of dynamism of investment, after years of decline during the debt crisis, impeded the modernization of domestic machinery and equipment. In this way, it sharply bounded the rise in productivity and international competitiveness. Second, exports, though they have certainly boomed, have been insufficiently linked to the domestic economy and tended to be either based on low-tech assembling activities (*maquiladoras*) or on natural-resource based manufactures with rather low or intermediate technological content. Thus they have failed to act as a dynamic engine of growth for the region. In fact, in the last four years (2003-06) the region has experienced a substantial economic recovery boosted by foreign demand -mainly for mineral inputs and natural resource based products-, the improvements in its terms of trade and a massive flow of family remittances from abroad. However, for most countries in the region, this recovery has not been accompanied by a surge in investment to guarantee persistent annual rates of economic expansion over and above the 6 per cent needed to generate sufficient jobs and soon alleviate poverty.

There is consensus that Latin America is at a crossroads. On the one hand, the region can not keep competing internationally on the basis of low wages, given that China and other East Asian economies have substantially lower unit labor costs. On the other hand, with few exceptions, its economies do not yet have the technological capacity or specialized human capital to successfully compete internationally at a large scale on high-tech products. In order for Latin America to succeed in its quest for high economic growth based on international trade in knowledge intensive goods and services, it must significantly strengthen its capacity to innovate, and ergo its capacity to carry out research and development. Such effort must recognize that public research universities are a pillar in the national innovation systems. To the extent that they play a key role in training human resources and carrying out research they have the potential to

affect the capacity of the economy -and the society- to successfully adapt to the globalized market and, ultimately, to join the ranks of developed nations. A key element in this regard is to translate such research and human capital formation into innovation and, thus, into faster productivity growth. This outcome, however, depends not only on the isolated efforts of such universities but also on the overall institutional context for innovation. In particular it depends on how is innovation linked with financial and productive capital so that it may be locally exploited in an efficient and effective way.

One important function of universities is to create a critical mass of scientists and engineers to work directly in industry, business and government. The developed countries' universities and technological institutes have been fulfilling this function completely for a long time. In these countries, large corporations have R&D departments that hire university graduates. These companies, together with government agencies, finance scientific and technological research projects in universities and research institutes. In addition, the private sector supplies funds for higher education and research through different mechanisms (see Tables 1 and 2). Lastly, it is noteworthy that in such countries, corporations tend to preferentially use technology produced by their own national system of innovation, allowing them to "own" knowledge generated both in-country as well as elsewhere and apply it to local production.

4. OBSTACLES TO THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN LATIN AMERICA

Generally speaking Latin American countries achievements -and perhaps capabilities- in creating innovative technology are found wanting (Martín del Campo, 1998; Cimoli, *et al.*, 2006). The region contributes less than 1.5 per cent of the world's scientific output (Tunnerman 2003), but accounts for 8.5 per cent of the world's total population. This is explained, partly, because in Latin America the conditions to put in place an efficient system of science, technology and innovation have been difficult, facing major obstacles. An important one is the feebleness or lack of private businesses funding and collaboration with universities and institutes for research and development. The situation is worsened by the fact that in Latin America, as in many semi-industrialized, developing economies, private firms have no R&D departments and tend to spend rather little overall on it. In general, they acquire their technology directly from abroad and devote scant resources to technical innovation beyond that concerning administrative or marketing processes. Moreover, local scientists, technological experts and researchers tend not be fully recognized as relevant factors of production in national industries nor as pecuniary interesting career options for the young.

Recent data available for Latin America estimates the number of researchers at around 150,000 including personnel working in the productive sector and in education. The ratio of researchers to total population is between 50 researchers per million inhabitants in Ecuador and 720 in Brazil. While Japan has 5,300 researchers per million of inhabitants and the US 4,600, Spain for example has 2,200 (see Table 1). Such performance is low by international standards (see Tables 3 and 4).

Modern universities in the western world, besides offering undergraduate and graduate programs in a wide area of disciplines, systematically carry out theoretical and applied research. In Latin America, in contrast, only a minority of the more than 2,500 academic institutions (private or public) defined as universities, go beyond undergraduate teaching and offer graduate programs in the areas of science and

technology. An even smaller number is engaged in scientific research and technology development. The few academic institutions that tend to do so are, typically, public universities.[6] Moreover close to 80 percent of the total of 2,500 universities are concentrated in only six countries and at the most an estimated 15 percent of the institutions have the effective capability to carry out research and development at internationally competitive standards (Martín del Campo, 1998).

There is no reason to believe that this situation has improved significantly in the last decade. Expenditure on science and technology is less than 0.5 percent of the gross domestic product (GDP) in the great majority of Latin American countries. In none of them exceeds 1 percent of GDP, the minimum proportion recommended by a number of international organizations. In the case of Mexico, for example, such expenditure averaged 0.4 percent of GDP over the last ten years. In contrast, Japan, the US, Korea, Germany, France and Canada spent between two and three percent of GDP into science and technology (see Table 3). It is also important to stress that in Latin America, most science and technology expenditures are made by the state (between 60 and 90 percent) either directly or through public institutions. The rest of the funding comes either from the private sector or from external sources. In contrast, in most developed countries the government financing makes up less than 50 percent of the total funding for R&D.

One additional element that in our region weakens the capacity to innovate as well as the potential impact of universities on economic growth is the fact that, in general, the distribution of science and technology expenditure does not favor engineering. This discipline receives only 10 percent of the total, thus greatly limiting the region's technological capability (Martín del Campo, 1998). Moreover, science and engineering careers average respectively no more than 30 per cent of graduates (see Table 5).

Another obstacle that the region and its research universities face is the lack of interaction and collaboration among Latin American scientists (Aréchiga, 1998) and between them and the local industry (Zubieta, *et al.*, 1999, Puchet-Anyul and Ruiz-Nápoles, 2005). As the data show, Latin American industries prefer to base their technological advancement on buying imported machinery, equipment and know-how from developed countries. Such reliance on imported capital goods and know-how is evidenced by the sharp deterioration of the trade balance in the upward phase if the business cycles when new investments are put in place.

As mentioned above, public universities and research institutions in Latin America are responsible for undergraduate/graduate programs as well as for the vast majority of local research in science and technology. Given this fact, it is necessary to differentiate state spending on science and technology from that on higher education. According to data here presented, public expenditure in Latin America to promote science and technology is very low in terms of GDP as compared to that of developed countries.

It is certainly necessary to make stronger efforts to augment public, and actually private, spending in these areas. However, besides this, it is most important to define

[6] In Latin America, most public universities engage in research. Thus, the distinction between public research universities and other public universities –so relevant in the US- is not so in our region. Note, however, that in general private universities in Latin America carry out little or no research.

lines of science and technology developments which may likely serve as engines of growth in the long run in terms of their impact on competitiveness and economic growth. Such identification is far from straight forward. However, the policy challenge is not that of "picking winners."[7] The challenge is to provide timely and relevant policy support tied to clearly defined performance criteria and, at the same time, of being able to cancel in time such support to sectors or firms that are not performing as expected. In other words the challenge is to "let losers go." In other words, the policy to develop key sectors should rely on transparent and temporary incentives: i) tightly linked to a given set of performance indicators and ii) granted in such a way that firms or activities that fail to meet the performance criteria are timely and effectively removed from the list of beneficiaries.

5. Higher Education and Graduate Programs in Latin America

For a number of reasons, in Latin America, public universities are responsible for the vast majority of postgraduate training, including science and technology. The bulk of qualified researchers working in these fields in our region has been trained and/or is at work in public universities. And, to the extent that a critical mass for research in science and technology there has been established in different countries in our region, it gravitates in public universities, and fundamentally funded supported by government funds.

In most countries of Latin America, higher education is in the hands of public institutions (see Table 5). Despite the fact that, for different reasons, over the last two decades the number of private institutions which compete in some fields with the public ones has significantly increased. Surprisingly enough, two thirds of higher education is run by public institutions also in the developed countries selected for comparison purposes (see Table 5). Here is where the highly qualified human resources are trained - and employed- and the main research laboratories and facilities have been built. Without public research universities the region would have dramatically few of its so much needed: professionals with solid education in specific branches of knowledge and the ability to constantly adapt and stay up to date in their fields. This includes the high-level scientists or engineers who can either go into production or dedicate themselves to research and to teaching.

According to UNESCO estimates, a little over 13 million students are enrolled in Latin America in what is defined as *tertiary* education (see Table 6). As with other indicators, 86 percent of such enrollment is concentrated in only seven countries in the region (Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela). It should be emphasized that in almost every country, one single major –business administration– concentrates 33 per cent of total enrollment, a percentage close to that of science, engineering and health combined. Note too that the average gross enrollment ratio[8] in most Latin American countries -except Argentina- (20-40 per cent) is less than half of that in most developed countries (50-90), (see Table 5). The graduation ratio is also less than half in Latin America (12.4 per cent) than in the developed countries (35.4 per cent) even though the teaching staff per student ratio is similar, reflecting somehow a

[7] Since the late 1990s there has been a revival of industrial policy both in the developed world as well as in semi-industrialized economies. For an analysis of the causes of this phenomenon see Rodrik (2004).

[8] Number of students currently enrolled, independent of their ages, divided by the age group population they should belong.

lower level of efficiency in our region. U.S. and European universities are preferred by master or doctoral candidates from several countries over the institutions in their own countries or regions. Latin American demand for studying in the United States is about 10 percent of the total, including undergraduate studies (UNESCO).

For different reasons, the demand for graduate studies increased significantly in the 1990s in some Latin American countries. The biggest increase was for master's programs, which concentrate 65 percent of all graduate students. By fields, the increase is mainly in the social and administrative sciences, the largest area of all (UDUAL, 1995). These trends appear to have continued in the last ten years and thus our graduate systems tend be favor master's programs, concentrated in the social and administrative sciences, mainly business administration, law, psychology, economics and social sciences.

Globalization and the stabilization plus structural adjustment programs have s imposed new demands on our public universities. In addition, the urgent need to transform and modernize our industrial apparatus and gear it to more knowledge intensive activities put additional pressure on them and, in general, on our national or regional innovation systems.

More specifically globalization, and the increased international competition that it has brought about, challenge public universities to meet world standards. As students, professors, researchers and funds acquire greater international mobility, public universities –and for that matter private ones too- must modernize and be competitive to keep blinking in the national monitor of education. For some universities the only effective response may be to specialize their research and teaching in some fields, closing down or trimming their curricula, departments and campuses. This option runs the risk of eliminating or weakening the capacity for interdisciplinary or multidisciplinary studies; a much valued trait that is at the essence of a university as originally conceived. For others, the way out may be to form alliances with top level universities and research centers in developed economies.

Pairing up our universities to meet international standards has many advantages, no doubt. But it has risks and costs. One of the risks is that our public universities research agenda may echo more and more the international one, with national problems taking the back seat in favor of more global concerns. In other words, our public universities have to meet the challenge of becoming more internationally competitive while at the same time preserving their national and regional relevance for economic and social issues.

The financial costs are evident too, as modernizing and improving research equipment and human capital will certainly requires additional funds. In this regard it is important to recall the impact of the intellectual climate that flourished in many Latin American countries against public institutions –including universities-. Indeed the wave -begun since the mid 1980s and until rather recently- against the public sector interventions combined with the structural fiscal weakness in the region led many governments to dwarf the funds to public universities. Such cuts, having more an ideological than a rational basis, were rationalized on two main grounds. The first one was that the subsidies to graduate education were seen as regressive, as they tend to benefit the middle class. The second was that, following the neo-liberal mantra, public

universities as any other public entities are inefficient and thus need to be disciplined by market forces. In any case, funds for public universities suffered a reduction in real terms. This reduction coupled with a trend to put in place performance-linked criteria and incentives for wages and salaries settlements has changed the working environment and capabilities in many public research universities. Whether such changes will strengthen or weaken the research capabilities of public research universities in Latin America must be assessed case by case.

Another key challenge that public research universities face is the need to absorb the increased demand for graduate and postgraduate education, inherent to our rapidly growing population. This challenge however can be adequately met only if the quality standards are maintained or raised. Finally, there is the issue of finding ways to strengthen the relation between public universities and the business community in order to enhance the nexus between training research innovation and national economic performance and competitiveness. This issue is examined in somewhat more detail in the following section. But, in any case, the way that public universities in Latin America -being at its center of research, development and training of highly qualified human capital- meet these challenges will likely determine the future development path of our region.

In the particular case of public spending in higher education in Latin America, we observe that in some leading countries the main problem lies not so much in the relative spending in terms of GDP as compared to developed countries (for instance Mexico is very close to the US, above 5 per cent), but in the direction in which it is concentrated. Without reducing the absolute amount of public spending in social sciences and the humanities, a stronger effort is required for engineering and natural and exact sciences, areas in which Latin America is way below developed countries. Moreover it is clear that to grow in the long-run at a high and constant rate, these economies need a highly qualified professional and labor force in science and technology.

6. THE MISSING LINK IN LATIN AMERICA: UNIVERSITY-INDUSTRY

Despite the wave of privatization oriented policies followed in Latin America, in the last twenty years, higher education institutions and research centers are still mostly public institutions funded by the State. These institutions carry out most of the highest levels of training of human resources in science and technology and almost all of the scientific and technological research done in the region.[9] It is precisely such public universities that, in Latin America, carry out the research and training in the fields currently crucial for innovation led growth.

However, if in most countries of the world the links between university research and industrial activities and performance are weak in our region this problem is worse. To broaden them and make them more conducive to growth an effective national innovation system is required comprising three factors: i) Human resources (research and technical personnel); ii) Adequate infrastructure (laboratories, workshops, computers, libraries) and iii) Institutions that link the academic research groups in the universities with the firms producing goods and services for the market. Such

[9] A particular and to some extent representative case is the one of the National Autonomous University of Mexico (UNAM), currently ranked worldwide by the Times Higher Education Supplement as number 74.

institutional framework includes a wide variety of possible alliances between government agencies, firms, and academic institutions that create an "innovation environment" (Shaihd, 2007).

This last element -the missing link- is a fundamental weakness in developing countries given that with notable exceptions their local private firms, and for that matter public ones too, typically do not have R&D departments. Indeed, a quick assessment of the Tables in the appendix regarding existing researchers, graduate enrollment, and public expenditure in research and development activities, directly or through higher education institutions, shows that Latin American countries in general have a weak basis to establish a strong innovation system with a potentially significant impact on economic growth. In particular, intellectual property rights, and funding sources for science and technological innovation are very scarce in most of the region.

However, in our view, the most acute limitation, or constraint is the lack of university-business links. In fact, except for some policy efforts in Argentina, Brazil, Chile, Mexico and Venezuela -not necessarily coordinated with corresponding industrial or sectoral policies- there are scant deliberate and significant government policies oriented to link research and training agenda of public universities -or private ones- with local firms' innovation needs. The university-industry links in developed countries were not established by chance or by market forces alone. In many of them there was a deliberate action by the state to promote a mutually beneficial relation between research centers (usually universities) and private (as well as public) firms in many industries. Thus it was a matter of state policy (Yusuf, 2007). In the case of Latin America these links are generally weak, in many cases virtually non-existent. This is, in our view, the fundamental missing element in the chain that goes from research to innovation and to economic growth. And as mentioned above, State action is required to overcome this constraint; to transform such missing university-firm link into a triad: university-government-industry.

How should the region move to meet the above identified challenges? [10] In principle one way, is to increase public investment in public higher education and research training across the board. However, the fragility and low revenues of Latin America's fiscal resources makes this option rather limited unless profound fiscal reforms are implemented. Another, perhaps with potentially more impact, is to pursue university-industry-government initiatives of research, innovation and development. Finally another one is to adapt specific targeted models including international collaborations. These options are not mutually exclusive, by any means. But, in any case, there is urgent need for future comparative research aimed at estimating the viability and potential costs/benefits of the different approaches based on international comparisons. This research could greatly advance our policies to move forward the transformation of public universities in Latin America to place them in a more relevant and significant role in the research-innovation-production process.

On this matter it is crucial to stop seeing innovation as something that occurs as a result of in-depth technological research in laboratories of big manufacturing firms in industrialized economies. This view, essentially correct for most of the twentieth century, is now questioned. As Vaitheeswaran (2007) pointed out, the advantage of the

[10] The authors acknowledge, and sincerely thank, Dr. Diana Rothen for sharing with them her ideas, expressed here in the last paragraph of this section.

big laboratories is reduced by the spread of information technologies that are speeding and easing the access to knowledge by smaller players in developing countries. And, moreover, as he stated, today much of innovation occurs in services and processes.

It is not clear, as of yet, of what would be the ideal form of the university-business firm links, appropriate to strengthen innovation in Latin American countries. In fact, at a world scale there is still a hot debate over this issue, given past and current experiences in various countries (Yusuf, 2007). Nobody seems to have the definitive answer. One reason is that innovation, as such, has many phases and forms. After all, it can be materialized in production processes, services or in management with changes that are conducive to augment productivity, to increase wealth. Incidentally, it may, or may not, involve new products or new ways of doing things. Or it may simply be achieved by applying old techniques to solve different needs.

In any case, given its diverse nature and expressions, even measuring innovation is not straight forward. Its manifestations in manufacturing or production processes are usually assessed by the number of patents or the introduction of modern, new techniques. This practice, although standard, may be rather inaccurate given that for many firms and countries –particularly in developing countries- the costs of patenting may outweigh its benefits. Moreover, in management and in many services, patenting is simply not applicable as a measure of innovation. This is of utmost importance if one recalls that services account for a vast proportion of the economic activity in developing many countries.

Thus, fostering innovation may certainly require funds and human capital, but also specific institutional arrangements tailored to the different countries or branches of productive activity concerned. The one-size fits all approach to innovation is simply not relevant. In this matter it is useful to point out that *at the level of the firm*, there is no evidence of a strong correlation between higher spending on research and development and the usual indicators of business performance: growth, profitability and shareholders return (Booze and Allen quoted by Vaitheeswaran, 2007).

One thing is clear though, without a specific long run strategy in which the state as well as the private sector are committed to promote innovation, Latin America will unlikely experience the significant and persistent boost in its productivity needed to enter a sustained path of high rates of economic growth.

7. CONCLUSIONS

Latin America's economic development urgently needs top level institutions capable of teaching and carrying out relevant and high quality research in science and technology. The innovation system now in place – in which public universities play a key role – is simply insufficient and ineffective to meet this challenge. In fact the institutional, financial and human resource bases for such systems are wanting. The number of active and in-training researchers in the different areas is still low, both in absolute and relative terms. As important as they are in our region, in general, public universities do not have a sufficiently adequate up-to-par existing infrastructure, human resources or functional links with the industrial or service sector. This impedes them to become a major force in pushing forward local technological progress and innovation. Thus, there is very little

real collaboration among the research community -including public universities- and the industrial or service producers.

These weaknesses can perhaps be seen more starkly in graduate programs, the basis for training high-level scientists and technicians. Absolute and relative enrollment size is low. The structure of graduate programs and higher education in general is uneven, to the detriment of the sciences and engineering. This forces Latin Americans to continue to get their graduate training in other countries. While in some Latin American countries there is what we could call the minimal basis for carrying out scientific-technological activities (infrastructure, researchers, basic and applied scientific production and graduate programs), it is not sufficient neither in quantity nor quality.[11]

Substantial political efforts and investments are needed, particularly in the short term, to train *human resources* better and in the additional volumes required by the demand. These efforts must not be isolated. The costs for public universities of training a scientist or high-level technician and of creating the conditions so that (s)he can carry out cutting-edge research are high and growing. This makes cooperation to create, maintain and develop science and technology systems a regional and national necessity, urging the coordinated work between the scientific communities and institutions of different Latin American countries, and among the governments, scientific communities and industrial representatives and groups in each country. Although mechanisms for Inter-American collaboration undeniably exist, up until now, scientific collaboration has not been used very much to strengthen national innovation systems (Ortega, 1998).

On the other hand, these investments' profitability is not immediately visible and in any case its benefit is higher in a social basis than on an individual perspective. When solely left to market criteria, there is the risk that these efforts and investments will not be made. Such positive externalities of research and development amply justify the activity of public research universities in our region. Public universities and other institutions of higher learning have the capacity to meet the society's demand to provide educational services as well the demand by local corporations, governments and academic institutions for qualified human resources. If institutions of higher learning operated exclusively on a profitability criterion, they would offer majors in professions in great market demand, to generate short term profits. Public universities guarantee that research and teaching in disciplines that, although not currently in demand by the private sector, they are crucial for long-term economic growth and development.

Scientific disciplines are precisely the most expensive and the ones that are seemingly least in demand today. That is why public universities must implement policies and operating criteria with an emphasis to boost them. It is indispensable that higher education be bolstered with resources from different sources as well as the State. Under current conditions, it would be very desirable for the private sector to also contribute without endangering educational institutions' indispensable autonomy. They must have the mandate –and hopefully the capacity- to plan for, finance and provide high quality training and research in disciplines that might not seem very profitable right now but that will be in demand and play an important role in the near future.

[11] The approximately 150,000 working researchers in Latin America produce only 1.5 percent of the articles published in internationally circulating peer-reviewed journals (see Martín Del Campo, 1998).

Economic growth requires specific quantities of technicians, professionals and scientists in different areas of the economy and society in order to achieve balanced development. Public research universities in Latin American as well as other institutions of higher learning face important challenges today. Perhaps the most crucial ones are to satisfy the demand for research and training high-level human resources in science and technology in sufficiently high numbers to promote economic growth based on comparative advantages rooted in knowledge intensive activities and not on unskilled, poorly paged workers. This must be done successfully complying with the degree of efficiency and quality set by the national and world economy.

To deal successfully with these challenges, public universities the institutions of higher learning and research must have the coordinated support of, both, the State and the private sector. Without their support, they will fail to modernize and strengthen their teaching and research capabilities. Moreover, as long as there is the missing link, the gap between their research agenda and the local business sectors' needs, the economies will find it increasingly difficult to compete internationally based on something else besides mineral/natural resources or in activities marked by the intensive use of cheap, unqualified labor. As long as this happens, economic development will be more and more a chimera than a concrete reality.

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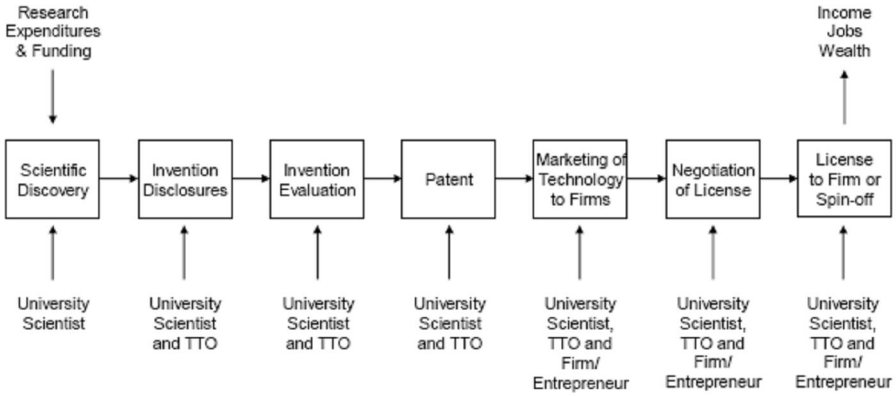
Figure 1



Source: Feldman and Stewart (2007).

TABLE 1
HUMAN RESOURCES IN RESEARCH AND DEVELOPMENT

Country	Year	Researchers							
		Researchers				Researchers by sector of employment			
		Full- time equivalent		Head Count		Business	Government	Higher	Private
		Total	Per mill. inh.	Total	Per mill. inh.	enterprise		Education	non-profit
Latin America									
Argentina	2003	27,367	720.1	43,609	1,147.4	3,101	10,201	13,485	580
Chile	2003	7,085	444.2	8,658	542.8	985	471	5,225	404
Uruguay	2002	1,242	366.3	3,839	1,132.1	12	166	1,064	n.a.
Cuba	2003	n.a.	n.a.	6,027	537.2	n.a.	n.a.	n.a.	n.a.
Costa Rica	1999	n.a.	n.a.	1,412	367.7	n.a.	n.a.	n.a.	n.a.
Venezuela	2003	n.a.	n.a.	6,100	236.3	n.a.	n.a.	n.a.	n.a.
Brazil	2000	59,838	344.2	n.a.	n.a.	15,989	4,736	38,701	412
Mexico	2002	27,626	268.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Peru	1997	5,576	225.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bolivia	2002	1,040	120.1	n.a.	n.a.	52	156	728	104
Colombia	2003	4,829	109.2	10,851	245.4	417	500	3,707	206
Ecuador	2003	645	50.2	845	65.7	n.a.	n.a.	n.a.	n.a.
Other Countries									
Japan	2003	675,330	5,286.9	830,545	6,502.0	458,845	33,711	172,396	10,378
United States	2002	1,334,628	4,605.0	n.a.	n.a.	1,066,000	47,822	208,806 *	12,000
Australia	2002	73,344	3,758.9	n.a.	n.a.	20,622	8,036	42,780	1,906
Canada	2002	112,624	3,596.9	n.a.	n.a.	69,634	7,820	34,910	260
Russia	2004	477,647	3,319.3	401,425	2,789.6	257,621	147,896	70,844	1,286
Germany	2004	269,500	3,260.9	n.a.	n.a.	162,000	40,000	67,500	n.a.
France	2003	192,790	3,212.7	240,186	4,002.6	100,646	24,541	64,403	3,200
Korea	2003	151,254	3,186.7	198,171	4,175.2	111,388	11,974	26,419	1,473
United Kingdom	2003	165,460 *	2,712.0 *	n.a.	n.a.	102,684	9,278	49,000 *	4,498
Spain	2003	92,523	2,195.4	158,566	3,762.5	27,581	15,489	49,196	258
Hong Kong	2002	10,639	1,563.8	n.a.	n.a.	3,142	212	7,285	n.a.
Italy	2003	70,332	1,213.5	107,454	1,853.9	26,866	13,976	27,774	1,716
China	2004	926,252	708.1	n.a.	n.a.	484,164	191,957	185,987	n.a.
India	1998	117,528	119.1	n.a.	n.a.	34,973	60,455	22,100	n.a.

*Estimated data
n.a. = not available
Source: UNESCO, IES, Global Education Digest 2006.

TABLE 2

GROSS EXPENDITURE ON RESERACH AND DEVELOPMENT (GERD)

Selected Countries	Year	Gross Expenditure on R&D			GERD by sector (%)				GERD by source (%)				
		PPP Dollars Millions	As percentage of GDP	Per capita PPP Dls	Business enterprise	Govern-ment	Higher Education	Private non-profit	Business enterprise	Govern-ment	Higher Education	Private non-profit	Abroad
Latin America													
Brazil	2003	13,487.0	0.98	74.35	n.a.	n.a.	n.a.	n.a.	41.0	30.4	28.6	n.a.	n.a.
Cuba	2003	n.a.	0.65	n.d.	0.0	0.0	0.0	0.0	35.0	60.0	0.0	0.0	5.0
Chile	2003	980.8	0.61	61.49	37.8	12.7	33.8	15.8	35.2	50.5	0.0	0.5	13.3
Argentina	2003	1,825.7	0.41	48.04	29.0	41.1	27.4	2.5	26.1	44.2	25.9	2.3	1.4
Mexico	2002	3,604.7	0.40	35.02	29.8	41.4	28.6	0.3	30.6	61.0	7.1	0.3	1.0
Costa Rica	2000	131.2	0.39	33.40	23.3	19.5	36.2	21.0	n.a.	n.a.	n.a.	n.a.	n.a.
Uruguay	2002	68.9	0.26	20.33	49.0	19.4	31.6	0.0	46.7	17.1	31.4	0.1	4.7
Venezuela	2003	359.0	0.28	13.91	0.0	0.0	0.0	0.0	1.0	71.6	27.4	0.0	0.0
Bolivia	2002	60.5	0.28	6.99	25.0	21.0	41.0	13.0	16.0	20.0	31.0	19.0	14.0
Peru	2003	149.7	0.10	5.51	9.8	35.4	44.7	10.1	n.a.	n.a.	n.a.	n.a.	n.a.
Ecuador	2003	32.4	0.07	2.52	12.9	34.9	10.8	41.4	n.a.	n.a.	n.a.	n.a.	n.a.
Other Areas													
Japan	2003	112,221.8	3.15	878.54	75.0	9.3	13.7	2.1	74.5	17.7	6.3	1.2	0.3
United States	2003	291,765.1	2.67	997.09	69.8	12.4	13.7	4.1	63.8	30.8	2.8	2.9	0.0
Korea	2003	22,761.5	2.64	479.56	76.1	12.6	10.1	1.2	74.0	23.9	1.7		0.4
Germany	2003	58,683.0	2.56	710.60	69.7	13.4	16.8	0.1	66.3	31.2	0.3	0.0	2.3
France	2003	36,717.4	2.22	611.87	62.6	16.7	19.4	1.3	50.8	39.0	1.9	0.0	8.4
Canada	2003	19,398.9	2.00	613.18	55.8	10.0	33.9	0.3	49.3	24.5	14.9	2.6	8.6
United Kingdom	2003	30,503.6	1.89	514.55	65.7	9.7	21.4	3.2	43.9	31.3	1.0	4.5	19.4
Australia	2002	9,499.2	1.70	486.84	51.2	19.3	26.7	2.8	48.8	42.4	4.7		4.1
China	2003	84,618.3	1.31	65.09	62.4	27.1	10.5	0.0	60.1	29.9	0.0	0.0	2.0
Russia	2003	16,926.4	1.28	117.04	68.4	25.3	6.1	0.2	30.8	59.6	0.5	0.2	9.0
Italy	2003	17,748.0	1.14	306.21	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Spain	2003	10,172.2	1.11	241.37	54.1	15.4	30.3	0.2	48.4	40.1	5.4	0.4	5.7
Hong Kong	2002	1,089.8	0.60	160.19	33.2	3.1	63.6	0.0	35.3	62.8	0.2	0.0	1.7

n.a. not available

Source: UNESCO, IES, Global Education Digest 2006.

TABLE 3
TERTIARY EDUCATION GRADUATES BY FIELD OF EDUCATION 2004

Selected Countries	Total number of graduates	Graduates by field of education as a % of total										
		Science and technology fields			Other fields							Not Known
		Total	Science	Engineering Manuf. & Const.	Total	Education	Humanities and Arts	Social Sciences	Agriculture	Health and Welfare	Services	
Latin America												
Brazil	497,598	12.8	7.2	5.6	80.9	27.0	3.2	35.0	1.8	12.1	1.8	6.3
Mexico	339,450	28.7	11.2	17.5	71.3	15.8	1.4	41.2	2.1	10.4	0.4	n.a.
Venezuela	101,112	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Colombia	65,720	24.7	2.3	22.4	75.3	17.3	2.3	46.3	0.7	8.8	n.a.	n.a.
Chile	64,364	26.3	0.9	25.3	73.7	12.5	6.0	40.9	4.3	10.0	n.a.	n.a.
Costa Rica	26,463	11.9	6.0	6.0	88.1	34.5	3.3	38.6	1.3	9.5	1.0	0.0
Bolivia	19,326	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Uruguay	7,476	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other Areas												
United States	2,473,299	12.4	7.0	5.4	72.1	11.1	13.1	36.5	0.9	6.4	4.0	15.5
China	1,948,080	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Russia	1,706,156	25.6	5.9	19.7	70.7	7.6	5.2	44.9	4.3	6.0	2.7	3.8
Japan	1,051,262	21.5	3.0	18.6	73.1	6.9	15.8	24.9	2.2	12.3	11.0	5.3
United Kingdom	595,641	22.7	14.6	8.1	75.5	9.9	15.3	30.9	1.0	17.8	0.7	1.8
France	584,849	29.3	13.0	16.3	70.6	6.6	12.4	39.7	0.3	7.6	4.1	n.a.
Germany	319,791	26.9	10.1	16.8	72.9	7.5	10.4	23.5	2.4	25.2	3.9	n.a.
Spain	298,448	27.9	11.0	16.9	72.1	11.2	9.3	29.3	2.1	12.9	7.2	n.a.
Italy	248,710	22.7	7.5	15.2	76.7	8.7	13.2	33.6	2.2	16.0	3.0	0.5
Australia	233,488	23.1	14.7	8.4	84.8	10.8	11.6	43.3	1.3	14.4	3.4	0.1
Hong Kong	53,104	28.0	12.4	15.6	47.1	9.4	7.5	26.5	n.a.	3.3	0.4	24.8

Source: UNESCO, IES, Global Education Digest 2006.

TABLE 4
EDUCATION EXPENDITURE, SOURCES 2004
as a percentage of GDP

	All sources		Public sources		Private sources		Inter-
	Total	Tertiary	Total	Tertiary	Total	Tertiary	national
Latin America							
Mexico	6.25	1.39	5.06	0.99	1.18	0.40	n.a.
Colombia	7.84	n.a.	4.90	n.a.	2.93	n.a.	n.a.
Costa Rica	4.78	0.93	4.73	0.93	n.a.	n.a.	0.05
Chile	7.23	2.20	3.97	0.38	3.26	1.83	n.a.
Argentina	4.74	1.09	3.94	0.70	0.80	0.39	n.a.
Peru	n.a.	n.a.	2.99	n.a.	n.a.	n.a.	n.a.
Uruguay	2.84	0.58	2.57	0.55	0.21	n.a.	0.06
Other Areas							
United States	7.44	2.70	5.49	1.22	1.95	1.48	n.a.
France	5.88	1.06	5.41	0.91	0.46	0.15	n.a.
United Kingdom	5.98	1.16	5.05	0.83	0.93	0.33	n.a.
Germany	5.30	1.08	4.42	0.98	0.87	0.09	0.01
Hong Kong	n.a.	n.a.	4.36	n.a.	n.a.	n.a.	n.a.
Spain	n.a.	n.a.	4.33	0.94	n.a.	n.a.	n.a.
Australia	5.83	1.57	4.33	0.76	1.51	0.81	n.a.
Korea	7.06	n.a.	4.12	n.a.	2.95	1.88	n.a.
Russia	n.a.	n.a.	3.84	0.65	n.a.	n.a.	n.a.
Japan	4.67	n.a.	3.48	n.a.	1.19	0.63	n.a.

n.a. = nota available

Source: UNESCO, IES, Global Education Digest 2006.

Selected Countries	Total enrolment	Percentages of the Total		Gross enrolment	Distribution of students by ISCED level (%)			Gross graduation	Teaching Staff	Student/ teacher
	Number	Public	Private	ratio	5A	5B	6	ratio 5A		ratio
World	**131,999,450**			**23.7**	**79.0**	**19.2**	**1.7**		**8,475,673**	**15.6**
Latin America	**12,099,953**	62.7	37.3	**34.1**	79.1	22.7		**12.4**		**13.2**
Argentina	2,026,735	78.9	21.1	61.1	74.0	25.7	n.a.	7.7	127,077	15.9
Chile	567,114	25.8	74.2	43.2	83.0	16.7	n.a.	15.8	n.a.	n.a.
Bolivia	346,056	n.a.	n.a.	40.6	n.a.	n.a.	n.a.	n.a.	17,759	19.5
Venezuela	983,217	72.9	27.1	39.3	61.6	34.3	4.1	11.5	n.a.	n.a.
Uruguay	98,520	89.8	10.2	37.8	76.3	23.6	n.a.	9.0	11,989	8.2
Cuba	235,997	100.0	0.0	33.0	98.9	n.a.	1.1	13.6	44,669	5.3
Peru	831,345	53.1	46.9	31.5	54.1	45.8	n.a.	n.a.	56,070	14.8
Colombia	1,112,574	45.0	55.0	26.9	81.8	18.1	n.a.	5.9	87,544	12.7
Mexico	2,236,791	66.8	33.2	22.5	96.6	2.9	n.a.	14.4	231,558	9.7
Brazil	3,582,105	31.7	68.3	20.1	n.a.	n.a.	n.a.	13.2	242,475	14.8
Costa Rica	79,499	n.a.	n.a.	19.0	85.2	14.6	n.a.	20.8	4,494	17.7
Other Areas	**62,780,117**	66.7	33.3	**59.9**	72.2	25.2		**35.4**		**15.8**
Korea	3,223,431	19.4	80.6	88.5	58.8	40.0	1.1	34.4	172,572	18.7
United States	16,900,471	76.1	23.9	82.4	76.6	21.1	2.2	34.5	1,174,831	14.4
Australia	1,002,998	99.2	0.8	72.2	79.9	16.4	3.7	46.9	n.a.	n.a.
Russia	8,622,097	88.8	11.2	68.2	74.9	23.3	n.a.	37.1	601,354	14.3
Spain	1,839,903	86.4	13.6	65.7	81.9	13.9	4.2	36.1	140,740	13.1
Italy	1,986,497	93.6	6.4	63.1	97.0	1.1	1.9	31.3	91,978	21.6
United Kingdom	2,247,441	0.0	100.0	60.1	73.2	22.8	4.0	39.1	111,830	20.1
Canada	1,192,570	n.a.	n.a.	57.2	72.5	25.4	2.2	32.9	131,320	9.1
France	2,160,300	83.6	16.4	56.0	71.5	23.8	4.7	42.7	135,783	15.9
Japan	4,031,604	23.0	77.0	54.0	73.8	24.4	1.8	36.8	496,370	8.1
Hong Kong	155,761	96.6	3.4	32.1	54.4	42.3	3.4	17.8	n.a.	n.a.
China	19,417,044	n.a.	n.a.	19.1	51.6	47.7	0.7	n.a.	850,227	22.8

ISCED International Standard Classification of Education.

5A= B.A. and M.A. programs; 5B = technical education ; 6 = Dotorate

n.a. = not available

Source: UNESCO, IES, Global Education Digest 2006.

TABLE 6
EDUCATION EXPENDITURE, SPENDING AS A % OF GDP 2004

Selected Countries	Total public expend. on education		Public expend. per Tertiary student as a % of GDP per cap.	Educational expenditure in Tertiary as a % of total educational expenditure in public inst.			
	as a % of GDP	as a % of total g.exp.		Salaries all Staff	Other Current	Total Current	Capital
Latin America							
Bolivia	6.4	18.1	35.9	n.a.	n.a.	100.0	n.a.
Mexico	5.3	n.a.	49.8	75.2	22.1	97.3	2.7
Costa Rica	4.9	18.5	n.a.	n.a.	n.a.	n.a.	n.a.
Colombia	4.9	11.7	26.3	49.7	37.5	87.2	12.8
Chile	4.1	19.1	15.3	61.7	31.4	93.2	6.8
Argentina	4.0	13.8	13.1	88.4	10.6	99.1	0.9
Peru	3.0	17.1	14.0	61.3	35.3	96.6	3.4
Uruguay	2.6	9.6	19.0	77.0	17.2	94.3	5.7
Cuba	n.a	19.4	n.a.	37.7	43.7	81.4	18.6
Other Areas							
United States	5.7	n.a.	25.9	53.5	37.2	90.7	9.3
France	5.6	n.a.	29.3	65.7	23.6	89.3	10.7
United Kingdom	5.3	11.5	28.8	n.a.	n.a.	n.a.	n.a.
Australia	4.9	n.a.	22.6	53.9	36.5	90.4	9.6
Germany	4.8	n.a.	n.a.	65.0	25.4	90.3	9.7
Italy	4.7	n.a.	27.4	52.7	30.7	83.4	16.6
Hong Kong	4.7	23.3	67.1	74.6	21.4	95.9	4.1
Spain	4.5	n.a.	23.1	64.4	16.1	80.5	19.5
Korea	4.2	15.5	n.a.	n.a.	n.a.	n.a.	n.a.
Russia	3.8	10.7	n.a.	n.a.	n.a.	n.a.	n.a.
Japan	3.6	n.a	17.1	56.5	27.9	84.4	15.6

n.a. = not available

Source: UNESCO, IES, Global Education Digest 2006.